Docket No. CA920000040US1 (7161-193U) **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of	:	Customer Number: 46320
Robert ENENKEL, et al.	:	Confirmation Number: 5643
Application No.: 10/008,473	:	Group Art Unit: 2123
Filed: November 9, 2001	:	Examiner: T. Stevens

For: METHOD AND APPARATUS FOR EVALUATING POLYNOMIALS AND RATIONAL FUNCTIONS

APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This Appeal Brief is submitted in support of the Notice of Appeal filed April 10, 2006, and in response to the Examiner reopening prosecution in the Office Action dated January 29, 2007, wherein Appellants appeal from the Examiner's rejection of claims 1-19 and 23-44.

I. REAL PARTY IN INTEREST

This application is assigned to IBM Corporation by assignment recorded on November 9, 2001, at Reel 012370, Frame 0073.

II. RELATED APPEALS AND INTERFERENCES

Appellants are unaware of any related appeals and interferences.

III. STATUS OF CLAIMS

Claims 1-19 and 23-44 are pending in this Application and have been four-times rejected. Claims 20-22 have been cancelled. It is from the multiple rejection of claims 1-19 and 23-44 that this Appeal is taken.

IV. STATUS OF AMENDMENTS

The claims have not been amended subsequent to the imposition of the Fourth Office Action dated January 29, 2007 (hereinafter the Fourth Office Action).

V. SUMMARY OF CLAIMED SUBJECT MATTER

Independent claims 1 and 23 are respectively directed to a machine-processing method and a machine for computing a property of a mathematically modeled physical system. The independent claims detail specific steps that are performed on a machine to output the value of a first polynomial as a floating point number. Independent claims 1 and 23 initially recite "reading, via a machine processing unit, input data including a value for each identified ordered coefficient of a first polynomial p(x) representing said property, said polynomial p(x) being expressed as $p(x) = \Sigma(Pj \bullet x^j)$ where j=0 to n, a value of a quantity x, a value of a predetermined x_i, and a value of a predetermined $p(x_i)$ correspondingly paired with said predetermined x_i," and support for this limitation is found in found Fig. 1, step 15, and also on pages 12 and 13 of Appellants' disclosure.

Claims 1 and 23 further recite "building, via said machine processing unit, a value of a second polynomial c(x) having ordered coefficients, said second polynomial c(x) being expressible as: $c(x) = \Sigma(C_k \bullet x^k)$ where k=0 to (n-1) so that said first polynomial p(x) is

expressible as: $p(x)=p(x_i)+\{x- x_i \} \bullet c(x)$," and support for this limitation is found in found Fig. 1, steps 30-50, and also on pages 14 and 15 of Appellants' disclosure with regard to equations 5, 5a, and 6. The building step further includes the steps of "i) determining, via said machine processing unit, a value for each ordered coefficient of said second polynomial c(x) by generating a plurality of machine processing unit signals to determine each said ordered coefficient of said second polynomial c(x) from: $C_k = \Sigma(P_{(k+1+j)} \bullet x^j_i)$ where j=0 to (n-1-k)" and "determining, via said machine processing unit, a value of said second polynomial c(x) by generating a plurality of machine processing unit signals to determine: $c(x) = \Sigma(C_k \bullet x^k)$ where k=0 to (n-1)" and support for these limitations are respectively found in Fig. 1, step 50, and also on pages 14 and 15 of Appellants' disclosure with regard to equation 6, and in Fig. 1, step 50, and also on pages 14 of Appellants' disclosure with regard to equation 5.

Claims 1 and 23 additionally recite "constructing, via said machine processing unit, a value of said first polynomial p(x) by generating a plurality of machine processing unit signals to determine: $p(x)=p(x_i)+\{x-x_i\} \bullet c(x)$," and support for this limitation is found in found Fig. 1, step 60, and also on page 14 of Appellants' disclosure with regard to equation 5a. Claims 1 and 23 finally recite "said value of the first polynomial is outputted as a floating point number and the floating point number is a digital representation of an arbitrary real number in said machine processing unit," which finds support on pages 1, 3, and 16 of Appellants' disclosure.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1-19 and 23-44 were rejected under 35 U.S.C. § 101;

2. Claims 1-4, 8-10, 23-24, 26, 30-32, and 41-44 were rejected under 35 U.S.C. § 103 for obviousness based upon "Modern Control Systems Analysis & Design Using MATLAB®" (hereinafter Bishop), in view of Kametani, U.S. Patent No. 4,870,608;

3. Claims 11 and 33 were rejected under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani and "An Accurate Elementary Mathematical Library for the IEEE Floating Point Standard" (hereinafter Gal);

4. Claims 5-7 and 27-29 were rejected under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani and Ito, U.S. Patent No. 4,398,263;

5. Claims 15-17 and 37-39 were rejected under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani and "Performance Evaluation of Programs for the Error and Complementary Error Functions" (hereinafter Cody);

6. Claims 18 and 40 were rejected under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani and "A Comparison of Computational Methods and Algorithms for the Complex Gamma Function" (hereinafter Ng); and

7. Claims 12-14 and 34-36 were rejected under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani and "The Student Edition of MATLAB version 5 User's Guide" (hereinafter Hanselman);

VII. ARGUMENT

THE REJECTION OF CLAIMS 1-19 AND 23-44 UNDER 35 U.S.C. § 101

For convenience of the Honorable Board in addressing the rejections, claims 2-19 stand or fall together with independent claim 1, and claims 24-43 stand or fall together with independent claim 23.

Referring to pages 1 and 2 of Appellants' disclosure, the solving of polynomials by a computer is not perfect. The steps for computing binary representations of numbers can create an unacceptably large deviation between a computed binary representation and its theoretical

numerical value due to successive rounding errors. Therefore, the "real" result from solving the polynomial (if the polynomial is solvable) may vary from the computed result obtained by the computer, sometimes to a great degree. In column 1, lines 12-49 of the newly cited reference, Kametani describes how a polynomial is operated on for a number of terms starting from an initial value to obtain a solution. Moreover, Kametani states the following:

> Basic operations <u>to solve the function with a sufficient accuracy</u>, that is, addition and multiplication require a large number of times of iteration of operation, and the execution time of the function operation is very long relative to the execution time of the basic operations.

Thus, Kametani supports Appellants' contention that the issue is just not to solve a polynomial equation, but to solve the equation with a greater degree of accuracy recognizing the limitations of computing binary representations of a number within a computer.

Although this information was informally provided to the Examiner, one having ordinary skill in the art would be aware of many instances where the differences between actual and computer-generated results from solving a polynomial have caused catastrophic failures. It is also well known that "rounding errors" and floating-point (i.e., a way of representing real numbers within a computer) are interrelated.

Referring to page 16 of Appellants' disclosure, it is well known that the precision of the floating-point number system in a particular computing system is definite and known, and this precision effects the rounding errors that are introduced into the process used by the computing system to solve the polynomial. Using the methodology described in claim 1, the present invention is directed to solving the polynomial with a greater precision than the inherent precision of the floating-point number system of the computing system. Therefore, the claimed invention is not just directed to solving an equation (i.e., the polynomial), as asserted by the

Examiner. Instead, the claimed invention is directed to improving the precision by which a particular computer system (i.e., the performance) is able to solve a polynomial equation beyond the precision inherent provided by the floating-point number system of the computer system.

The Examiner's Arguments in the Fourth Office Action

The Examiner's arguments on page 3 of the Fourth Office Action are essentially identical to those arguments found on pages 3 and 4 of the Third Office Action. These arguments were addressed by Appellants in the First Appeal Brief, and Appellants' arguments are reproduced below.

The Examiner, for example, has asserted that:

> In practical terms, claims define nonstatutory processes if they:
>
> - consist solely of mathematical operations without some claimed practical application (i.e., executing a "mathematical algorithm"); or
>
> - simply manipulate abstract ideas, e.g., a bid [Schrader, 22 F.3d at 293-94, 30 USPQ2d at 1458-59) or a bubble hierarchy (Warmerdam, 33 F.3d at 1360, 31 USPQ2d at 1759) without some claimed practical application.
>
> Thus, a claim that recites a computer that solely calculates a mathematical formula (see Benson) or a computer disk that solely stores a mathematical formula is not directed to the type of subject matter eligible for patent protection.

In re Shrader improperly relied upon

Notwithstanding the Examiner's reliance upon In re Shrader, the Federal Circuit recognizes that the court in In re Shrader did not apply a proper analysis. As stated in M.P.E.P. § 2106(I), "[o]ffice personnel should no longer rely on the Freeman-Walter-Abele test to determine whether a claimed invention is directed to statutory subject matter." The court in In re Shrader, however, relied on the Freeman-Walter-Abele test. The failure of the court in In re Shrader to

rely upon a proper standard is discussed in AT&T Corp. v. Excel Communications, Inc.,[1] which states:

> Similarly, the court in In re Schrader relied upon the Freeman - Walter - Abele test for its analysis of the method claim involved. The court found neither a physical transformation nor any physical step in the claimed process aside from the entering of data into a record. See 22 F.3d at 294, 30 USPQ2d at 1458. The Schrader court likened the data-recording step to that of data-gathering and held that the claim was properly rejected as failing to define patentable subject matter. See id. at 294, 296, 30 USPQ2d at 1458-59. The focus of the court in Schrader was not on whether the mathematical algorithm was applied in a practical manner since it ended its inquiry before looking to see if a useful, concrete, tangible result ensued. Thus, in light of our recent understanding of the issue, the Schrader court's analysis is as unhelpful as that of In re Grams.

Therefore, the Examiner cannot properly rely upon In re Schrader to support the rejection of claims 1-19 and 23-44 under 35 U.S.C. § 101.

The Federal Circuit in AT&T Corp. also addressed In re Warmerdam[2], in which the Court stated:

> Finally, the decision in In re Warmerdam, 33 F.3d 1354, 31 USPQ2d 1754 (Fed. Cir. 1994) is not to the contrary. There the court recognized the difficulty in knowing exactly what a mathematical algorithm is, "which makes rather dicey the determination of whether the claim as a whole is no more than that." Id. at 1359, 31 USPQ2d at 1758. Warmerdam's claims 1-4 encompassed a method for controlling the motion of objects and machines to avoid collision with other moving or fixed objects by generating bubble hierarchies through the use of a particular mathematical procedure. See id. at 1356, 31 USPQ2d at 1755-56. The court found that the claimed process did nothing more than manipulate basic mathematical constructs and concluded that "taking several abstract ideas and manipulating them together adds nothing to the basic equation"; hence, the court held that the claims were properly rejected under 101. Id. at 1360, 31 USPQ2d at 1759. Whether one agrees with the court's conclusion on the facts, the holding of the case is a straightforward application of the basic principle that mere laws of nature, natural phenomena, and abstract ideas are not within the categories of inventions or discoveries that may be patented under 101.

An algorithm is patentable when applied in "useful" way

In State Street Bank and Trust Company v. Signature Financial Group, Inc.,[3] the court elaborated on the mathematical algorithm exception to patentable subject matter by stating:

[1] 172 F.3d 1352, 50 USPQ2d 1447 (Fed. Cir. 1999).
[2] 33 F.3d 1354, 31 USPQ2d 1754 (Fed Cir. 1994)
[3] 149 F.3d 1368, 47 USPQ2d 1596 (Fed Cir. 1998).

> Unpatentable mathematical algorithms are identifiable by showing they are merely abstract ideas constituting disembodied concepts or truths that are not "useful." From a practical standpoint, this means that to be patentable an algorithm must be applied in a "useful" way.

The court in State Street then set forth the criteria for establishing statutory subject matter under 35 U.S.C. § 101 as follows:

> The question of whether a claim encompasses statutory subject matter should not focus on which of the four categories of subject matter a claim is directed to —process, machine, manufacture, or composition of matter—but rather on the essential characteristics of the subject matter, in particular, its practical utility. Section 101 specifies that statutory subject matter must also satisfy the other "conditions and requirements" of Title 35, including novelty, nonobviousness, and adequacy of disclosure and notice. See In re Warmerdam, 33 F.3d 1354, 1359, 31 USPQ2d 1754, 1757-58 (Fed. Cir. 1994). For purpose of our analysis, as noted above, claim 1 is directed to a machine programmed with the Hub and Spoke software and admittedly produces a "useful, concrete, and tangible result." Alappat, 33 F.3d at 1544, 31 USPQ2d at 1557. This renders it statutory subject matter, even if the useful result is expressed in numbers, such as price, profit, percentage, cost, or loss.

Thus, as articulated above, the test for determining whether subject matter is patentable under 35 U.S.C. § 101 involves deciding if the subject matter produces a "useful, concrete, and tangible result." Furthermore, the law states that this result can be "expressed in numbers."

Appellants have established utility

A discussion of the procedural considerations regarding a rejection based upon lack of utility (i.e., 35 U.S.C. § 101) is found in M.P.E.P. § 2107.02. Specifically, M.P.E.P. § 2107.02(I) states that:

> regardless of the category of invention that is claimed (e.g., product or process), an applicant need only make one credible assertion of specific utility for the claimed invention to satisfy 35 U.S.C. 101 and 35 U.S.C. 112

In the paragraph spanning pages 1 and 2 of the disclosure and within the "Background of the Present Invention" section, Appellants stated the following:

> Steps for computing binary representations of numbers can create an unacceptably large deviation between an computer binary representation and its theoretical numerical value due to successive rounding errors. This can be an intolerable situation when a higher degree of accuracy

> is required. Various methods can improve computation accuracy but they may require a significant increase in processing time and/or hardware.

As recognized by those skilled in the art, a floating-point number is a digital representation of an arbitrary real number in a computer. As alluded to by Appellants in the above-reproduced passage, rounding errors[4] with floating point numbers can degrade computation accuracy. In the second full paragraph on page 16 of the disclosure, Appellants stated with regard to the invention the following:

> Optionally, accuracy can be further improved by choosing x_i such that $p(x_i)$ has extra accuracy beyond the precision of the floating-point number system of the computer.

Appellants, therefore, have asserted a credible utility (i.e., improving the precision of a floating-point number system in a computer).

As noted in M.P.E.P. § 2107.02(III)(A), the Court of Customs and Patent Appeals in In re Langer[5] stated the following:

> As a matter of Patent Office practice, a specification which contains a disclosure of utility which corresponds in scope to the subject matter sought to be patented must be taken as sufficient to satisfy the utility requirement of § 101 for the entire claimed subject matter unless there is a reason for one skilled in the art to question the objective truth of the statement of utility or its scope. (emphasis in original)

Since a credible utility is contained in Appellants' specification, the utility requirement of 35 U.S.C. § 101 (i.e., whether the invention produces a useful, concrete, and tangible result) has been met.

Claim 23

Although claims 1-19 are directed to a method, Appellants note that claims 23-44 are directed to a machine, and on this basis, without the need for further argument, claims 23-44 are

[4] E.g., 2/3 is not perfectly represented by .66666667.
[5] 503 F.2d 1380, USPQ 288 (CCPA 1974).

directed to statutory subject matter. In the decision of In re Warmerdam,[6] the Court concluded that the method claims recited in claims 1-4 "[involve] no more than the manipulation of basic mathematical constructs, the paradigmatic 'abstract idea.'" The Court then sustained the rejection of claims 1-4 under 35 U.S.C. § 101.

However, the Court noted that claim 5 of the same application recited "[a] machine having a memory which contains data representing a bubble hierarchy generated by the method of any of Claims 1 through 4." With regard to this claim, the Court stated that "[c]laim 5 is for a machine, and is clearly patentable subject matter" despite the prior finding that method being performed by the machine was non-statutory subject matter. Therefore, since claims 23-44 are directed to a machine, then claims 23-44 are directed to statutory subject matter within the meaning of 35 U.S.C. § 101.

The Examiner's Response to Appellants' Prior Arguments

On page 14 of the Fourth Office Action, the Examiner's sole response to all of the arguments presented above is the following:

> 15. Applicants are thanked for addressing these issues. Solving rounding errors inside a computer is a subset of the arithmetic process and not a final specific activity (e.g., to reduce logic gates or calculate lottery numbers). In comparison, the algorithm used in State Street is application specific i.e., final share price, while the application's solution of a floating point number is silent towards a specific activity. The rejection, as stated above, stands.

At the outset, Appellants note that the Examiner has not addressed many, if not all, of Appellants' specific arguments. Instead, the Examiner's "response" appears to be merely a statement by the Examiner that "I disagree" without any additional meaningful comment.

6 33 F.3d 1354, 31 USPQ2d 1754 (Fed. Cir. 1994).

Moreover, the Examiner has mischaracterized the claimed invention in a fundamental way. Appellants' invention does not solve rounding errors. Appellants' claimed invention, while solving a polynomial, improves the accuracy of a computer beyond that provided by the inherent precision of the floating-point number system within the computer.

The Examiner also asserted that "the application's solution of a floating point number is silent towards a specific activity." A claim to an improved transistor, whose useful, concrete, and tangible result is to increase the speed of a computer in which the transistor is located, does not require a specific recitation of the final application being performed by the computer. Reference is also made to claim 8 of the Examiner's new cited reference of Kametani, which is reproduced below:

> 8. A method for floating point operation for calculating an approximate solution for a given argument of a function in accordance with a microprogram, said method comprising the steps of:
>
> storing in a memory solutions of coefficient functions of a series polynomial approximate equation, said coefficient functions including coefficient functions having proper solutions corresponding to respective arguments to be given, said memory storing solutions corresponding to all of the arguments to be given;
>
> reading from said memory a solution of the coefficient function corresponding to the argument of said function; and
>
> carrying out a floating point operation of the series polynomial approximate equation based on the solution read from said memory to calculate said approximate solution.

As it pertains to statutory subject matter within the meaning 35 U.S.C. § 101, Appellants note little difference between the subject matter found in method claim of claim 8 of Kametani and the subject matter found in the method claims recited in claims 1-19 of the present application.

<u>THE REJECTION OF CLAIMS 1-4, 8-10, 23-24, 26, 30-32, AND 41-44 UNDER 35 U.S.C. § 103 FOR OBVIOUSNESS BASED UPON BISHOP IN VIEW OF KAMETANI</u>

For convenience of the Honorable Board in addressing the rejections, and claims 2-4, 8-10, 23-24, 26, 30-32, and 41-44 stand or fall together with independent claim 1.

On page 5 of the Fourth Office Action, the Examiner essentially relied upon Bishop to teach: i) computing a property of a mathematically modeled physical system, ii) input data; and iii) outputting via a machine-processing unit. The Examiner then relied on Kametani to teach the remainder of the limitations of claim 1, as described on pages 5 and 6 of the Fourth Office Action. Appellants will produce each of the limitations recited in claim 1 along with the Examiner's cited passage in Kametani which allegedly discloses these features. As readily evident upon comparing the claimed limitations to the actual teachings, Kametani fails to teach or suggest many of these claimed limitations:

Independent claim 1 recites, in part, the following limitations:

> a) reading, via a machine processing unit, input data including a value for each identified ordered coefficient of a first polynomial p(x) representing said property,

On page 5 of the Fourth Office Action, to teach the "reading, via a machine processing unit," the Examiner cited column 4, lines 19-31, and to teach the remainder, the Examiner cited column 2, lines 60-65, which is reproduced below:

> By parallelly controlling the operation unit and the table memories by the microsequencer, the operation time is also reduced because the values of the coefficient functions can be read from the table memories during the execution of the operation.

Appellants respectfully disagree with the Examiner's assertion that column 2, lines 60-65 teaches or suggests the limitation regarding the "input data including ..." This passage cited by the Examiner is a generalization and makes no mention of a polynomial or a value of reach identified ordered coefficient of the polynomial.

Independent claim 1 further recites, in part, the following limitations:

> said polynomial p(x) being expressed as $p(x) = \Sigma(P_j \bullet x^j)$ where j=0 to n, a value of a quantity x, a value of a predetermined x_i, and a value of a predetermined $p(x_i)$ correspondingly paired with said predetermined x_i.

On page 5 of the Fourth Office Action, the Examiner asserted "Taylor series," and for support, the Examiner cited column 4, lines 52-66, which is reproduced below:

> An approach to an approximate solution of a function by using a Taylor series is now explained.
>
> F(X) is a function to be solved, X is an argument, and X' is a neighborhood value of the argument X.
>
> The Taylor series of f(X) is given by
>
> $$\sum_{n=0}^{m} \frac{1}{n!} f^{(n)}(X') \bullet (X - X')^n \qquad (1)$$
>
> where f(n)(X') is an n-th differentiation of f(x'). The formula (1) is expressed by
>
> $$\sum_{n=0}^{m} a^n (X') \bullet X^n \qquad (2)$$

Upon comparing the claimed polynomial p(x) with the above-reproduced teachings of Kametani, Appellants are unclear as to how these teachings of Kametani teach or suggest the claimed polynomial p(x) since the respective equations appear to be different.

Independent claim 1 further recites, in part, the following limitations:

> b) building, via said machine processing unit, a value of a second polynomial c(x) having ordered coefficients, said second polynomial c(x) being expressible as: $c(x) = \Sigma(C_k \bullet x^k)$ where k=0 to (n-1) so that said first polynomial p(x) is expressible as: $p(x)=p(x_i)+\{x- x_i\} \bullet c(x)$.

On page 6 of the Fourth Office Action, the Examiner cited column 5, equation (3), and equation (3) is reproduced below:

$$f(x) \approx a_0(X') + a_1(X') \bullet X \qquad (3)$$

Again, as with the Examiner's citation of equations (1) and (2) with regard to the claimed first polynomial p(x), Appellants are unclear as to how equation (3) of Kametani teach or suggest the claimed second polynomial c(x) since the respective equations appear to be different. Moreover, Appellants also note that in column 4, line 68, Kametani teaches that equation (2) is "one-order approximated to get" equation (3). As recited above, "said first polynomial p(x) is expressible as: $p(x)=p(x_i)+\{x- x_i\} \bullet c(x)$." However, this relationship between p(x) and c(x) is completely absent from equation (3).

Independent claim 1 further recites, in part, that the build step includes the following two limitations:

> i) determining, via said machine processing unit, a value for each ordered coefficient of said second polynomial c(x) by generating a plurality of machine processing unit signals to determine each said ordered coefficient of said second polynomial c(x) from: $C_k = \Sigma(P_{(k+1+j)} \bullet x^j_i)$ where j=0 to (n-1-k);
>
> ii) determining, via said machine processing unit, a value of said second polynomial c(x) by generating a plurality of machine processing unit signals to determine: $c(x) = \Sigma(C_k \bullet x^k)$ where k=0 to (n-1).

On page 6 of the Fourth Office Action, regarding the "determining ... a value for each ordered coefficient" in claimed step (i), the Examiner cited equation (2), and to teach the remainder of

claimed step (i), the Examiner cited equation (3). Regarding the "determining ... a value of said second polynomial c(x)" in claimed step (ii), the Examiner asserted "series of polynomials and cited column 2, lines 5-10, and to teach the remainder of step (ii), the Examiner cited equation 2 while asserting "where k = 0 to (n-1)." For ease of reference, column 2, lines 3-11 is reproduced below:

> As the number of types of functions to be operated on increases, the number of types of tables is increased accordingly. It is desirable from a standpoint of the operation speed that a table is provided for each group of series polynomials which constitute a series polynomial approximate equation. The floating point operation is executed under the control of the microsequencer in accordance with the microprogram.

How this above-reproduced passage discloses determining a value of a second polynomial c(x), as claimed, is unclear to Appellants. Moreover, the connection between this passage and equation (2) is also unclear since equation (2) has been alleged by the Examiner to meet the claimed limitations of how the value of the second polynomial c(x) is determined.

Moreover, Appellants note that the Examiner has cited equations (2) and (3) as teaching the various limitations recited above in claimed steps (i) and (ii). Again, as with the Examiner's prior citations of equations (1), (2), and (3), Appellants are unclear as to how equations (2) and (3) of Kametani teach or suggest the limitations recited in claimed steps (i) and (ii). For example, the Examiner relied upon equation (3) to teach "[determining] each said ordered coefficient of said second polynomial c(x) from: $C_k = \Sigma(P_{(k+1+j)} \bullet x^j_i)$ where j=0 to (n-1-k)." However, upon comparing equation (3) of Kametani to this limitation, Appellants observe little similarity.

Independent claim 1 further recites, in part, the following limitations:

> c) constructing, via said machine processing unit, a value of said first polynomial p(x) by generating a plurality of machine processing unit signals to determine: $p(x)=p(x_i)+\{x-x_i\} \bullet c(x)$.

On page 6 of the Fourth Office Action, regarding the "constructing ... a value of said first polynomial p(x)," the Examiner asserted "series of polynomials and cited column 2, lines 5-10, and to teach the remainder of claimed step (c), the Examiner cited column 5, lines 15-30, which is reproduced below:

> where a_0 (X') and a_1 (X') are coefficient functions of the function f(X). As many coefficient functions at the neighborhood value X' of X as is sufficient to assure the accuracy of the approximate solution are precalculated and stored in the table memory 10. In the operation of the function f(X), when the argument X is given, the value X' closest to the argument X is read from the register file, the address thereof is set into the address latch 9, the coefficient function of X' is read from the table memory 10 and loaded to the arithmetic and logic circuit 5 and the multiplier 6, and a Taylor series approximate solution of the function f(X) is calculated by floating point operation.
>
> The operation for a function f(X)=SIN (X) is explained in detail. Since f(X)=SIN (X), f(X')=SIN (X'), f'(X')=COS (X').

How this passage relates to "generating a plurality of machine processing unit signals to determine: $p(x)=p(x_i)+\{x-x_i\} \bullet c(x)$" is, again, unclear to Appellants.

Independent claim 1 finally recites, in part, the following limitations:

> d) outputting, via said machine-processing unit, said value of the first polynomial p(x) representing said property of the mathematically modelled physical system, wherein
>
> said value of the first polynomial is outputted as a floating point number and the floating point number is a digital representation of an arbitrary real number in said machine processing unit.

On page 6 of the Fourth Office Action, regarding the "outputting ... said value of said first polynomial p(x)," the Examiner cited column 2, lines 5-10, and to teach the " floating point number is a digital representation of an arbitrary real number," the Examiner separately cited column 2, line 48 for "floating point" and column 6, lines 31-54 for the remainder of the limitation. For ease of reference, column 2, lines 45-48 is reproduced below:

> In this manner, it is possible to control the microprogram with a small number of simple basic operations and a small number of operation steps to carry out the function operation in the floating point operation unit. Accordingly, compared with the prior art system which obtains a solution by a convergence type iterative operation, the number of times of performance of basic operations can be reduced to one third (depending on the table resolution power) and the function operation time is significantly reduced accordingly.

Although this passage describes the use of a "floating point operation unit," this passage is silent as to the value of the first polynomial being outputted as a floating point number.

Therefore, for the reasons stated above, Kametani fails to teach or suggest all of the claimed limitations for which Kametani is being relied upon by the Examiner to teach. Thus, even if one having ordinary skill in the art were motivated to combine the applied prior art, as suggested by the Examiner, the proposed combination of references would not yield the claimed invention. Appellants, therefore, respectfully submit that the imposed rejection of claims 1-4, 8-10, 23-24, 26, 30-32, and 41-44 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani is not viable.

THE REJECTION OF CLAIMS 11 AND 33 UNDER 35 U.S.C. § 103 FOR OBVIOUSNESS BASED UPON BISHOP IN VIEW OF KAMETANI AND GAL

For convenience of the Honorable Board in addressing the rejections, and claims 11 and 13 stand or fall together with independent claim 1.

Claims 11 and 33 depend from independent claims 1 and 23, and Appellants incorporate herein the arguments previously advanced in traversing the imposed rejection of claims 1 and 23 under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani. The tertiary reference to Gal does not cure the argued deficiencies of the combination of Bishop and Kametani. Accordingly, even if one having ordinary skill in the art were motivated to combine the applied prior art, as suggested by the Examiner, the proposed combination of references would not yield the claimed invention. Appellants, therefore, respectfully submit that the imposed rejection of claims 11 and 33 under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani and Gal is not viable.

THE REJECTION OF CLAIMS 5-7 AND 27-29 UNDER 35 U.S.C. § 103 FOR OBVIOUSNESS BASED UPON BISHOP IN VIEW OF KAMETANI AND ITO

For convenience of the Honorable Board in addressing the rejections, and claims 5-7 and 27-29 stand or fall together with independent claim 1.

Claims 5-7 and 27-29 depend from independent claims 1 and 23, and Appellants incorporate herein the arguments previously advanced in traversing the imposed rejection of claims 1 and 23 under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani. The tertiary reference to Ito does not cure the argued deficiencies of the combination of Bishop and Kametani. Accordingly, even if one having ordinary skill in the art were motivated to combine the applied prior art, as suggested by the Examiner, the proposed combination of references would not yield the claimed invention. Appellants, therefore, respectfully submit that the imposed rejection

of claims 5-7 and 27-29 under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani and Ito is not viable.

THE REJECTION OF CLAIMS 15-17 AND 37-39 UNDER 35 U.S.C. § 103 FOR OBVIOUSNESS BASED UPON BISHOP IN VIEW OF KAMETANI AND CODY

For convenience of the Honorable Board in addressing the rejections, and claims 15-17 and 37-39 stand or fall together with independent claim 1.

Claims 15-17 and 37-39 depend from independent claims 1 and 23, and Appellants incorporate herein the arguments previously advanced in traversing the imposed rejection of claims 1 and 23 under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani. The tertiary reference to Cody does not cure the argued deficiencies of the combination of Bishop and Kametani. Accordingly, <u>even if</u> one having ordinary skill in the art were motivated to combine the applied prior art, as suggested by the Examiner, the proposed combination of references would not yield the claimed invention. Appellants, therefore, respectfully submit that the imposed rejection of claims 15-17 and 37-39 under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani and Cody is not viable.

THE REJECTION OF CLAIMS 18 AND 40 UNDER 35 U.S.C. § 103 FOR OBVIOUSNESS BASED UPON BISHOP IN VIEW OF KAMETANI AND NG

For convenience of the Honorable Board in addressing the rejections, and claims 18 and 40 stand or fall together with independent claim 1.

Claims 18 and 40 depend from independent claims 1 and 23, and Appellants incorporate herein the arguments previously advanced in traversing the imposed rejection of claims 1 and 23 under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani. The tertiary reference to Ng does not cure the argued deficiencies of the combination of Bishop and Kametani. Accordingly, even if one having ordinary skill in the art were motivated to combine the applied prior art, as suggested by the Examiner, the proposed combination of references would not yield the claimed invention. Appellants, therefore, respectfully submit that the imposed rejection of claims 18 and 40 under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani and Ng is not viable.

THE REJECTION OF CLAIMS 12-14 AND 34-36 UNDER 35 U.S.C. § 103 FOR OBVIOUSNESS BASED UPON BISHOP IN VIEW OF KAMETANI AND HANSELMAN

For convenience of the Honorable Board in addressing the rejections, and claims 12-14 and 34-36 stand or fall together with independent claim 1.

Claims 12-14 and 34-36 depend from independent claims 1 and 23, and Appellants incorporate herein the arguments previously advanced in traversing the imposed rejection of claims 1 and 23 under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani. The tertiary reference to Hanselman does not cure the argued deficiencies of the combination of Bishop and Kametani. Accordingly, even if one having ordinary skill in the art were motivated to combine the applied prior art, as suggested by the Examiner, the proposed combination of references would not yield the claimed invention. Appellants, therefore, respectfully submit that the imposed

rejection of claims 12-14 and 34-36 under 35 U.S.C. § 103 for obviousness based upon Bishop in view of Kametani and Hanselman is not viable.

Conclusion

Based upon the foregoing, Appellants respectfully submit that the Examiner's rejections under 35 U.S.C. §§ 101, 103 are not viable. Appellants, therefore, respectfully solicit the Honorable Board to reverse the Examiner's rejections under 35 U.S.C. §§ 101, 103.

To the extent necessary, a petition for an extension of time under 37 C.F.R. § 1.136 is hereby made. Please charge any shortage in fees due under 37 C.F.R. §§ 1.17, 41.20, and in connection with the filing of this paper, including extension of time fees, to Deposit Account 09-0461, and please credit any excess fees to such deposit account.

Date: February 16, 2007

Respectfully submitted,

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VIII. CLAIMS APPENDIX

1. A machine-processing method for computing a property of a mathematically modelled physical system, the steps comprising:

a) reading, via a machine processing unit, input data including a value for each identified ordered coefficient of a first polynomial p(x) representing said property, said polynomial p(x) being expressed as $p(x) = \Sigma(Pj \bullet x^j)$ where j=0 to n, a value of a quantity x, a value of a predetermined x_i, and a value of a predetermined $p(x_i)$ correspondingly paired with said predetermined x_i;

b) building, via said machine processing unit, a value of a second polynomial c(x) having ordered coefficients, said second polynomial c(x) being expressible as: $c(x) = \Sigma(C_k \bullet x^k)$ where k=0 to (n-1) so that said first polynomial p(x) is expressible as: $p(x)=p(x_i)+\{x- x_i \} \bullet c(x)$, comprising the steps of:

i) determining, via said machine processing unit, a value for each ordered coefficient of said second polynomial c(x) by generating a plurality of machine processing unit signals to determine each said ordered coefficient of said second polynomial c(x) from: $C_k = \Sigma(P_{(k+1+j)} \bullet x^j_i)$ where j=0 to (n-1-k);

ii) determining, via said machine processing unit, a value of said second polynomial c(x) by generating a plurality of machine processing unit signals to determine: $c(x) = \Sigma(C_k \bullet x^k)$ where k=0 to (n-1);

c) constructing, via said machine processing unit, a value of said first polynomial p(x) by generating a plurality of machine processing unit signals to determine: $p(x)=p(x_i)+\{x-x_i\} \bullet c(x)$; and

d) outputting, via said machine-processing unit, said value of the first polynomial p(x) representing said property of the mathematically modelled physical system, wherein

said value of the first polynomial is outputted as a floating point number and the floating point number is a digital representation of an arbitrary real number in said machine processing unit.

2. The machine-implementable method of claim 1, wherein a difference between x and x_i is sufficiently small to achieve a desired accuracy of a final computation of said machine representation of a numerical value of said first polynomial p(x).

3. The machine-implementable method of claim 2 wherein the step of reading said input data comprises reading, via said machine processing unit, said input data from a machine-readable medium.

4. The machine-implementable method of claim 3 wherein said ordered coefficients of said second polynomial c(x) are computed from a mathematical expression derivable from: $C_k = \Sigma(P_{(k+1+j)} \bullet x^j_i)$ where j=0 to (n-1-k).

5. The machine-implementable method of claim 4 wherein said mathematical expression is a mathematical recurrence expression.

6. The machine-implementable method of claim 5 wherein said mathematical recurrence expression is a forward mathematical recurrence expression.

7. The machine-implementable method of claim 5 wherein said mathematical recurrence expression is a backward mathematical recurrence expression.

8. The machine-implementable method of claim 7 further adapted to implement said backward mathematical recurrence expression by comprising further steps for:

e) equating, via said machine-processing unit, a value of a highest ordered coefficient of said second polynomial c(x) to a value of an identified highest ordered coefficient of said first polynomial p(x) by generating a plurality of machine processing unit signals to determine: $C_{n-1}=P_n$; and

f) computing, via a machine processing unit, a value for each lower ordered coefficient of said second polynomial c(x) by generating a plurality of machine processing unit signals to determine:C_k-1=$x_i \bullet C_k+P_k$ where k = (n-1) to 1.

9. The machine-implementable method of claim 8 wherein said predetermined x_i is selected from a set of predetermined values of x_i.

10. The machine-implementable method of claim 9 wherein said predetermined x_i is a closest member of said set to said identified x.

11. The machine-implementable method of claim 10 wherein said step of determining a value of said second polynomial c(x) is computed by using Homer's Rule.

12. The machine-implementable method of claim 11 for determining a value of a denominator polynomial q(x) having identified ordered denominator coefficients, said denominator polynomial q(x) being expressible as: $q(x) = \Sigma(Q_j \bullet x^j)$ where j=0 to m, comprising further steps of:

g) adapting said input data to further include a value for each identified ordered denominator coefficient of said denominator polynomial q(x), a value of a predetermined $q(x_i)$ correspondingly paired with said predetermined x_i; and

h) determining, via said machine processing unit, a value of another polynomial d(x) having ordered denominator coefficients, said another polynomial d(x) being expressible as: $d(x) = \Sigma(D_k \bullet x^k)$ where k = 0 to (m-1) so that said denominator polynomial q(x) is expressible as: $q(x) = q(x_i)+\{x- x_i \} \bullet d(x)$, and a value for the said denominator polynomial is resolved.

13. The machine-implementable method of claim 12 wherein the first polynomial p(x) is a numerator polynomial p(x), and $p(x)-p(x_i)$ is computed, and $p(x_i)$ is not read.

14. The machine-implementable method of claim 13 for determining a value of a rational function r(x) being expressible as a quotient of said numerator polynomial p(x) and said denominator polynomial q(x) expressed as r(x) = p(x) / q(x), comprising further steps of:

i) adapting said input data to further including a value of a predetermined $r(x_i)$ correspondingly paired with said predetermined x_i; and

j) constructing, via said machine processing unit, a value of said rational function r(x) by generating a plurality of machine processing unit signals to determine:

$r(x) = r(x_i) \bullet (1 - (q (x)-q (x_i))/q(x))) + (p(x) - p(x_i))/q(x)$.

15. The machine-implementable method of claim 14 wherein said rational function r(x) is an approximation to a Bessel function.

16. The machine-implementable method of claim 14 wherein said rational function r(x) is an approximation to an error function (ERF).

17. The machine-implementable method of claim 14 wherein said rational function r(x) is an approximation to a complementary error function (ERFC).

18. The machine-implementable method of claim 14 wherein said rational function r(x) is an approximation to a log gamma function (LGAMMA).

19. The machine-implementable method of claim 11 or 14 wherein all values are machine representations of some numerical value, said machine processing unit is a computer processing unit, each machine representation is a binary representation operable with said computer processing unit, and machine-readable medium is a computer-readable medium.

23. A machine for computing a property of a mathematically modelled physical system, the machine configured to perform the steps comprising:

a) reading, via a machine processing unit, input data including a value for each identified ordered coefficient of a first polynomial p(x) representing said property, said polynomial p(x) being expressed as $p(x) = \Sigma(P_j \bullet x^j)$ where $j = 0$ to n, a value of a quantity x, a value of a

predetermined x_i, and a value of a predetermined $p(x_i)$ correspondingly paired with said predetermined x_i;

b) building, via said machine processing unit, a value of a second polynomial c(x) having ordered coefficients, said second polynomial c(x) being expressible as: $c(x) = \Sigma(C_k \bullet x^k)$ where $k = 0$ to $(n-1)$ so that said first polynomial p(x) is expressible as: $p(x) = p(x_i)+\{x-x_i\} \bullet c(x)$, comprising the steps of:

i) determining, via said machine processing unit, a value for each ordered coefficient of said second polynomial c(x) by generating a plurality of machine processing unit signals to determine each said ordered coefficient of said second polynomial c(x) from: $C_k=\Sigma(P_{(k+1+j)}\, x^j_i)$ where $j= 0$ to $(n-1-k)$;

ii) determining, via said machine processing unit, a value of said second polynomial c(x) by generating a plurality of machine processing unit signals to determine: $c(x) = \Sigma(C_k \bullet x^k)$ where $k = 0$ to $(n-1)$;

c) constructing, via said machine processing unit, a value of said first polynomial p(x) by generating a plurality of machine processing unit signals to determine: $p(x)=p(x_i)+\{x- x_i\} \bullet c(x)$; and

d) outputting, via said machine-processing unit, said value of the first polynomial p(x) representing said property of the mathematically modelled physical system, wherein

said value of the first polynomial is outputted as a floating point number and the floating point number is a digital representation of an arbitrary real number in said machine for computing.

24. The machine of claim 23 wherein a difference between x and x_i is sufficiently small to achieve a desired accuracy of a final computation of said machine representation of a numerical value of said first polynomial p(x).

25. The machine of claim 24 wherein said means for reading said input data comprises means for reading, via said machine processing unit, said input data from a machine-readable medium.

26. The machine of claim 25 wherein said ordered coefficients of said second polynomial c(x) are computed from a mathematical expression derivable from: $C_k = \Sigma(P_{(k+1+j)} \bullet x^j_i)$ where j= 0 to (n-1-k).

27. The machine of claim 26 wherein said mathematical expression is a mathematical recurrence expression.

28. The machine of claim 27 wherein said mathematical recurrence expression is a forward mathematical recurrence expression.

29. The machine of claim 27 wherein said mathematical recurrence expression is a backward mathematical recurrence expression.

30. The machine of claim 29 further adapted to implement said backward mathematical recurrence expression by further comprising:

e) means for equating, via said machine processing unit, a value of a highest ordered coefficient of said second polynomial c(x) to a value of an identified highest ordered coefficient of said first polynomial p(x) by generating a plurality of machine processing unit signals to determine: $C_{n-1} = P_n$; and

f) means for computing, via said machine processing unit, a value for each lower ordered coefficient of said second polynomial c(x) by generating a plurality of machine processing unit signals to determine: $C_{k+1} = x_i \bullet C_k + P_k$ where $k = (n-1)$ to 1.

31. The machine of claim 30 wherein said predetermined x_i is selected from a set of predetermined values of x_i.

32. The machine of claim 30 wherein said predetermined x_i is a closest member of said set to said identified x.

33. The machine of claim 32 wherein the determining means for determining a value of said second polynomial c(x) is computed by using Homer's Rule.

34. The machine of claim 33 for determining a value of a denominator polynomial q(x) having identified ordered denominator coefficients, said denominator polynomial q(x) being expressible as: $q(x) = \Sigma(Q_j \bullet x^j)$ where $j = 0$ to m, comprising further steps of:

g) adapting said input data to further include a value for each identified ordered denominator coefficient of said denominator polynomial q(x), and a value of a predetermined $q(x_i)$ correspondingly paired with said predetermined x_i; and

h) determining, via said machine processing unit, a value of another polynomial $d(x)$ having ordered denominator coefficients, said another polynomial $d(x)$ being expressible as: $d(x) = \Sigma(D_k \bullet x^k)$ where $k = 0$ to $(m-1)$ so that said denominator polynomial $q(x)$ is expressible as: $q(x)=q(x_i)+\{x- x_i\} \bullet d(x)$, and a value for the said denominator polynomial is resolved.

35. The machine of claim 34 wherein the first polynomial $p(x)$ is a numerator polynomial $p(x)$, and $p(x)-p(x_i)$ is computed, and $p(x_i)$ is not read.

36. The machine of claim 35 for determining a value of a rational function $r(x)$ being expressible as a quotient of said numerator polynomial $p(x)$ and said denominator polynomial $q(x)$ expressed as $r(x) = p(x) / q(x)$, comprising further steps of:

i) adapting said input data to further including a value of a predetermined $r(x_i)$ correspondingly paired with said predetermined x_i; and

j) constructing, via said machine processing unit, a value of said rational function $r(x)$ by generating a plurality of machine processing unit signals to determine:

$r(x) = r(x_i) \bullet (1 - (q(x)-q(x_i))/q(x))) + (p(x) - p(x_i))/q(x)$.

37. The machine of claim 36 wherein said rational function is an approximation to a Bessel function.

38. The machine of claim 36 wherein said rational function is an approximation to an error function (ERF).

39. The machine of claim 36 wherein said rational function is an approximation to a complementary error function (ERFC).

40. The machine of claim 36 wherein said rational function is an approximation to a log gamma function (LGAMMA).

41. The machine of claim 33 or 36 wherein all values are machine representations of some numerical value, said machine processing unit is a computer processing unit, each machine representation is a binary representation operable with said computer processing unit, and said machine-readable medium is a computer-readable medium.

42. A machine having a computer-readable program product having computer executable instructions for instructing a computer to embody the machine of claim 41.

43. A machine having a computer-readable mathematical software routine library including computer executable instructions for instructing a computer to embody the machine of claim 41.

44. A machine having the computer-readable mathematical software routine library of claim 43 wherein said library is operatively associated with a software programming language.

IX. EVIDENCE APPENDIX

No evidence submitted pursuant to 37 C.F.R. §§ 1.130, 1.131, or 1.132 of this title or of any other evidence entered by the Examiner has been relied upon by Appellants in this Appeal, and thus no evidence is attached hereto.

X. RELATED PROCEEDINGS APPENDIX

Since Appellants are unaware of any related appeals and interferences, no decision rendered by a court or the Board is attached hereto.